Sweet SPOT™ for Daylighting

The Problem

Daylighting systems, which use natural lighting to supplement electric lighting, have the potential to cut energy use, reduce peak demand, and create a more desirable indoor environment, yet these systems often fail to live up to their potential. One reason they fail is that they are sensitive to photosensor placement and performance, but there have been no easy-to-use tools to help designers predict performance and determine optimum sensor positioning.

The Solution

The Sensor Placement and Orientation Tool (SPOT™) is a free software package that helps designers establish correct photosensor placement relative to a proposed daylighting and electric lighting design (**Figure 1**). It also analyzes and predicts overall system performance prior to field installation and commissioning.

Features and Benefits

Anyone who can use Microsoft Excel can use SPOT. The user interface is an Excel worksheet, while most of the calculations made, using a sophisticated daylighting software program known as Radiance, are invisible to the user. Based on user input, the tool calculates nighttime illumination levels and the range of daylight contribution throughout the year. Advanced users can also access Radiance to further customize the calculations.

SPOT accounts for many variables such as room geometry, surface reflectances, solar orientation, electric lighting layout, and window design. The major elements include:

Project information. To start a project, the user sets the project name and the performance measurement units to be used.

Options. The SPOT user has options to direct the program to create renderings, include a variety of shading devices, set reflectivity and rotation angles of blinds, and specify the types of light shelves to be analyzed.

Geometry input. The user defines the room geometry and electric lighting layout for the space to be analyzed. The program also lets the user define reflectances of all the surfaces in the room or building and of the ground outside as well as specify any overhangs and light shelves to be considered for shading purposes. For electric lighting, the user can also define the type of luminaire to be used.

Site and usage. This section allows the user to define the location of the building, set schedules for occupancy, and establish the desired control strategy for the shading device. Weekly and annual schedules are accommodated.

Design tools. Once the project has been fully specified, the software moves into the design phase. The design portion of SPOT uses the geometry and site information provided and reports three main sets of information back to the user: electric lighting performance under nighttime conditions, annual daylighting performance under a sampling of conditions (**Figure 2**, next page), and photosensor placement recommendations for each luminaire zone.

Analysis. The analysis portion of SPOT allows the user to apply various photosensor placements to the luminaire zones, adjust the photosensor system settings, and run annual performance calculations. A Photosensor Analyzer screen allows users to mix and match the various photosensor

Figure 1: Sensor placement and orientation tool

SPOT™ software, a tool for daylighting system analysis and design, can be downloaded from the Internet free of charge. This screen shot shows recommended photosensor locations.

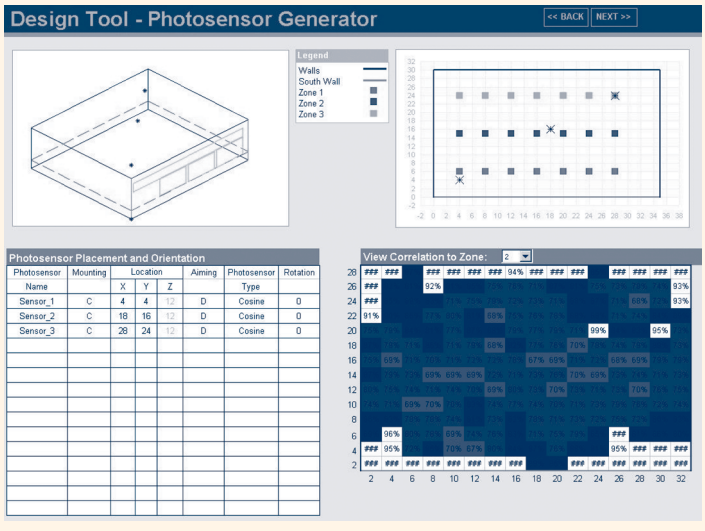
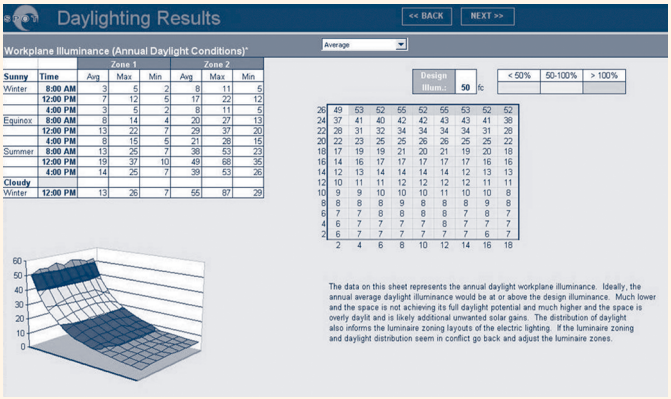


Figure 2: Daylighting results

This output screen from SPOT™ shows the workplane illumination levels as they vary in the course of a day and throughout the year.



scenarios defined previously and analyze how they will perform under a larger set of representative days and sky conditions. An Annual Analysis screen provides a more accurate analysis of the photosensor system by accounting for climate conditions, schedules, and the time of day.

Applications

SPOT was developed with classrooms in mind, but it also may be applied to other spaces such as offices. The software handles top and side daylight sources and can model any electric lighting source from IES (Illuminating Engineering Society) files.

To install SPOT, users' computers must meet the following specifications:

- Windows 2000, NT, or XP
- Excel 97 (or higher)
- 400-MHz processor
- 128 MB available disk space

California Codes and Standards

SPOT will help designers effectively comply with the daylighting requirements in California's Title 24 energy code. Title 24 requires separate controls for daylit areas and offers substantial energy budget credits for automatic daylighting controls. The 2005 version of the code favors measures, such as daylighting, that save energy during periods of likely peak demand. In addition, the code now requires skylights with daylighting controls for the top story of spaces larger than 25,000 square feet that have ceilings higher than 15 feet.

What's Next

Currently, SPOT only allows the input of simple, right-angled space geometries. Future versions will allow more-complex geometry to be modeled in other computer-aided design packages and imported to the program. Other goals for SPOT include developing an extensive database of manufacturers' photosensor performance, encouraging widespread use of the free software, setting up demonstration projects, and training users.

Collaborators

Architectural Energy Corp. developed the SPOT software.

For More Information

Reports documenting this project and providing more details may be downloaded from the web at www.archenergy.com/lrp/products/spot.htm.

The software may be downloaded from the web at www.archenergy.com/SPOT/index.html.

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About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) program. PIER supports public-interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

Arnold Schwarzenegger, *Governor* **For more information see** www.energy.ca.gov/pier

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